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Small Mammal Use of a Desert Riparian Island and Its Adjacent Scrub Habitat

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The restriction of water flow in 1959 in Queen Creek by Whitlow Ranch Dam, Pinal County, Arizona created a 15-ha riparian island upstream, behind the dam. Small mammal populations in the riparian interior, riparian edge, desert wash, and upland habitats were sampled to assess the value of this type of development for mitigating continued loss of riparian habitat. The riparian island had few small mammals; more were recorded in the adjacent desert washes and desert upland habitats. Habitat models were developed for the desert shrew *(Notiosorex crawfordi)*, Arizona pocket mouse *(Perognathus amplus)*, and Bailey's pocket mouse *(Perognathus baileyi)*.

Keywords: Small mammals, microhabitat use, riparian mitigation, habitat relationships

Management Implications

The gallery willow forest examined in this study supported few small mammals. Many more were recorded in the adjacent desert washes and desert upland. The potential is limited for using the development of a dense willow gallery forest resulting from changes in hydrologic regime as a mitigating factor for more structurally diverse riparian habitats. Perhaps opening up the canopy allowing for the increased development of the shrub and herbaceous layers would greatly increase the value of this system as small mammal habitat. However, the ecological replacement of a riparian fauna by mainly nonmigratory small mammal species may only be accomplished by the introduction of riparian species from other sites, particularly in such isolated "island" situations.

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Introduction

For the past decade, riparian habitats have been recognized as having an importance and biological interest disproportionate to their size. Gallery forests of cottonwood (*Populus* spp.) and willow (*Salix* spp.) provide some of the richest terrestrial vertebrate faunas in the Southwest (Carothers et al. 1974, Szaro 1980). Degradation of riparian habitats in the southwestern United States by human activities has continually reduced the acreage of these critical wildlife areas. However, development of riparian vegetation above and below dams, impoundments, canals, and other water projects is one method of mitigating some of these losses (Szaro 1981, Szaro and Jakle 1985).

Small mammal abundance has been related to several measures of habitat structure (M'Closkey 1975, Holbrock 1978, Geier and Best 1980). Structural diversity and habitat size are major determinants of mammalian community structure (Dueser and Brown 1980, Yahner 1983). Availability of suitable microhabitats, coupled with habitat selection by individual species, affects population size and diversity (Yahner 1982, Adler 1985).

This study was designed to: (1) determine relationships between species abundance and vegetation, (2) compare the use patterns of small mammals in riparian and adjacent desert scrub habitats, and (3) determine the effects of a flood control dam on a small mammal community resulting from the development of a Goodding willow (*Salix gooddingii*)-salt cedar (*Tamarix pentandra*) gallery forest.

Study Area

The study area is on Queen Creek, about 3.7 km upstream from the mouth of Whitlow Canyon, and about 16 km west of Superior, Ariz. A 15-ha stand of Goodding willow-salt cedar, approximately 350 x 450 m, resulted from the restriction of water flow by Whitlow Ranch Dam built in 1959; the area is surrounded by sonoran desert scrub. The interior of the riparian stand is 78% Goodding willow and 22% saltcedar (based on the total basal area of stems >2.5 cm). A border of vegetation approximately 35 m wide along the edge of the stand is composed of 60% saltcedar, 39% Goodding willow, and 1% velvet mesquite (*Prosopis velutina*). Total shrub cover is less than 1% in the riparian interior, but more than 27% along the riparian edge; it consists primarily of seepwillow baccharis (*Baccharis salicifolia*).

Two washes extend northward perpendicular to the long edge of the stand. Tree species composition in the washes is 45% velvet mesquite, 35% saguaro (*Cereus giganteus*), and 17% littleleaf paloverde (*Cercidium microphyllum*). On the upland benches, which extend from the riparian area parallel to the washes, tree species composition is 76% saguaro and 21% littleleaf paloverde. Total shrub cover is 20% in the washes and 18% on the upland benches. Dominant shrubs in the washes are catclaw acacia (*Acacia greggii*), creosotebush (*Larrea tridentata*), seepwillow baccharis, and desert hackberry (*Celtis pallida*). On the benches, the dominant shrubs are burrobush (*Ambrosia deltoidea*), creosotebush, buckwheat (*Eriogonum fasciculatum*), littleleaf ratany (*Krameria parvifolia*), California jojoba (*Simmondsia chinensis*), Sonora jumping cholla (*Opuntia fulgida*), and Engelmann prickly pear (*O. engelmanii*). For a complete description of the vegetation, see Szaro and DeBano (1985).

Methods

Forty pitfall trap stations were established—10 each in the interior of the riparian stand, around the edge of the stand, along a desert wash, and on the desert upland. Desert upland and wash traps were set on 1-km lines perpendicular to the riparian site, at 100-m intervals. The riparian points were spaced at 100-m intervals in a grid pattern, with 10 interior and 10 edge traps. The trap design was a simplified version of those described by Jones (1981) and Campbell and Christman (1982).

Each station consisted of one drift fence (7 m long x 0.2 m high) with a 19-liter plastic bucket buried flush with the ground at each end of the fence. Plastic lids were positioned 3–5 cm above the bucket rims and were supported by a projection of the drift fence, rocks, or sticks. These covers protected trapped animals from desiccation and overheating caused by insolation, and attracted species that use cover for foraging, predator avoidance, or thermoregulation. Drift fences in the desert wash were oriented perpendicular to the wash to reduce the number of animals trapped while crossing the wash and to increase the likelihood of capturing animals using the wash.

Between April 12 and May 24, 1982, traps were checked 3 times each week. Total number of trap days for each station was 43 (860 bucket-days per habitat; 3440 bucket-days for the entire study).

Because trapping effort was the same for each zone and location, capture rate was used as an activity-density measure. It is more appropriate than simple presence/absence data at a given trap station, because it considers local distribution of activity, an important component of microhabitat use (M'Closkey 1981).

Vegetation data were collected during the first 3 weeks of May 1982. Plots of 15 m-radius (0.07 ha) were analyzed around the center of each trap location. All trees >2.5 cm diameter at breast height were measured, and tree species were recorded. All shrubs, including saplings and seedlings, were counted, and the diameters and heights of the first 20 shrubs of each species in each plot were measured. Shrub cover for each plot then was calculated using a mean shrub size for that plot or actual shrub cover/0.07 ha for those shrub species with fewer than 20 individuals.

Regression models were developed for the most abundant small mammal species. Analyses began with an examination of 53 habitat variables, including tree density and basal area (BA) for each tree species, cover values for all shrub species, total shrub cover, total tree density, total basal area, high shrub cover (shrubs >1 m in height), low shrub cover (shrubs <1 m), riparian tree density, desert tree density, riparian tree basal area, and desert tree basal area.

Initial analyses showed high intercorrelations between many variables. Only those variables with the best predictive value were retained, and those highly correlated but of less predictive value were eliminated from further analyses. Final analyses used 15 variables (velvet mesquite BA, foothill paloverde BA, Goodding willow BA, cover values of catclaw acacia, burrobush, desert hackberry, littleleaf paloverde (shrub size), graythorn (*Condalia lycioides*), mormon tea (*Ephedra* spp.), littleleaf ratany, wolfberry (*Lycium* spp.), and velvet mesquite (shrub size), high shrub cover, low shrub cover, and total basal area). Analyses were run on all 40 points only if a small mammal species was found both in riparian and desert habitats. If a species was collected only on desert habitats, further analyses used only the data from the 20 desert points, or vice versa in the case of species collected only in riparian habitats.

Analyses were performed using BMDP procedure All Possible Subsets Regression (Frane 1981). "Best" subsets of predictor variables were determined using Mallow's

Cp, which is the relationship between the residual sum of squares of the independent variables and the residual mean square based on the regression using all independent variables adjusted for sample size and the number of independent variables (Frane 1981).

Results and Discussion

Only six species, desert shrew *(Notiosorex crawfordi)*, pallid bat *(Antrozous pallidus)*, Arizona pocket mouse *(Perognathus amplus)*, Bailey's pocket mouse *(Perognathus baileyi)*, cactus mouse *(Peromyscus eremicus)*, and whitethroated woodrat *(Neotoma albigula)*, were caught during this study (table 1). Rodent population density usually responds to shrub density (Hafner 1977). However, in a shrub-steppe ecosystem, shrub architecture and food resources did not directly affect most rodents; but shrubs may be important to them in the long-term by providing sites for germination and growth of herbaceous vegetation (Parmenter and MacMahon 1983).

In this study, there was no significant correlation between rodent density and shrub density ($r = 0.06$, $p > 0.1$). There was a slight correlation between rodent density and overall shrub cover ($r = 0.51$, $p < 0.1$). Most animals were trapped in the desert wash (58%) where Bailey's pocket mouse was the single most abundant mammal. Three species, the pallid bat, whitethroated woodrat, and cactus mouse, were trapped only in riparian habitats; the Arizona pocket mouse was trapped only in desert habitats.

The riparian island had fewer small mammals but greater species diversity (H') than the adjacent desert habitats. This was a result of greater evenness resulting from low numbers of all riparian species (table 1). Other studies have reported less evenness, richness, and diversity in riparian communities as compared to adjacent desert plant communities (Boeer and Schmidly 1977, Szaro and Belfit 1986). Also, the largest numbers of both species and specimens were found in the driest habitat in the Gilboa Mountains of Israel (Warburg et al. 1978). However, there appears to be no valid generalization regarding small mammal diversity in riparian and adjacent upland habitats. Probably the ecological history of each species influences its use of a habitat. Some xeric-adapted species (e.g., pocket mice) rarely or never use riparian habitat; other species (e.g., woodrats) often use riparian zones when available.

Table 1.—Total pitfall capture (3,440 trap days) during the 6-week study period in riparian and desert habitats near Whitlow Ranch Dam, Arizona, spring 1982.

Species	Riparian Interior	Riparian Edge	Desert Wash	Desert Upland
Desert Shrew	1	6	1	
Pallid Bat	3			
Arizona pocket mouse			13	14
Bailey's pocket mouse		2	25	5
Cactus mouse	1	2		
Whitethroated woodrat		2		
Total Captures	5	12	49	19
Species Richness	3	4	3	2
Species Diversity (H ')[1]	0.950	1.243	0.776	0.576

[1] *$H' = -\Sigma P_i \ln(P_i)$, where P_i is the propostion of a given mammal species.*

The habitat relationships of the three most abundant species, desert shrew, Arizona pocket mouse, and Bailey's pocket mouse, indicated different patterns with respect to the 15 vegetation variables examined (table 2). Significant regression models were obtained for predicting species abundance in all three cases.

Habitat use by the desert shrew was directly related to velvet mesquite and saltcedar basal area plus velvet mesquite shrub cover (table 2). This reflects the shrews' high abundance in the riparian edge. Few shrews were trapped in the moist riparian interior, because they primarily occur in areas with little or no free water (Hoffmeister and Goodpaster 1962).

Previous microhabitat studies of Bailey's pocket mouse and Arizona pocket mouse emphasized various measures of shrub cover and habitat openness to explain differences in abundance between the two species (Price 1978, Stamp and Ohmart 1978). M'Closkey (1981) found that the Arizona pocket mouse prefers microhabitats containing small shrubs; Bailey's pocket mouse has a propensity for microhabitats with more medium-sized shrubs. Bailey's pocket mouse was associated with grassy or open areas in shrubby habitats, especially if shrubs contributed a moderate amount of overstory (Rosenzweig and Winokur 1969). The scarcity of this mouse in mesquite communities may be related to sporadic grassy or open areas (Stamp and Ohmart 1978).

In this study, Bailey's pocket mouse was trapped primarily at wash sites with large shrubs and small trees with a substantial understory of red brome *(Bromus rubens*, $16 \pm 3\%$). The regression model for Bailey's pocket mouse reflects this subjective assessment by incorporating tree form catclaw acacia and three large shrub variables which explain 86% of its variability in abundance (table 2). Price (1978) also found Bailey's pocket mouse preferred large bush and tree dominated sites. Moreover, red brome and burrobush are preferred food items for this species (Stamp and Ohmart 1978).

Many Arizona pocket mice in desert shrub habitats compared to few in creosote and mesquite shrubs indicates this species might prefer a smaller range of shrubby habitat (Stamp and Ohmart 1978). This species was equally abundant on both the desert upland and desert wash habitats. Habitat use by this species indicated a significant relationship between capture numbers and low shrub variables, plus the evenly dispersed littleleaf paloverde (64 ± 15 trees/ha in the wash versus 66 ± 14 trees/ha in the desert upland, table 2). The Arizona pocket mouse prefers habitats with small open areas (Price 1978). This preference is reflected by an examination of trap locations within the desert wash and upland habitats. Although the Arizona pocket mouse was evenly dispersed on the upland sites, it was found only on the last 600 meters in the desert wash. The first 400 meters of the wash is an area dominated by large shrubs

Table 2.—Best set regression models for predicting mammalian species abundance using vegetation variables from desert and riparian habitats near Whitlow Ranch Dam, Arizona, spring 1982.

Species and variable	Coefficient	SE	Contribution[1] to r^2	SE of the estimate	r^2	F	$P > \infty$
Desert Shrew							
Intercept	-0.049	0.073		0.31	.601	18.08	<0.0001
Velvet mesquite BA	0.791	0.382	0.048				
Salt cedar BA	0.535	0.173	0.106				
Velvet mesquite cover	0.002	0.001	0.270				
Arizona Pocket Mouse							
Intercept	0.096	0.472		1.09	.601	5.64	0.0056
Littleleaf paloverde BA	9.566	4.175	0.139				
Buckwheat cover	0.061	0.030	0.106				
Littleleaf ratany cover	0.171	0.051	0.290				
California jojoba cover	-0.418	0.122	0.314				
Bailey's Pocket Mouse							
Intercept	0.209	0.140		0.70	.863	42.81	<0.0001
Catclaw acacia BA	-261.069	38.726	0.183				
Burrobush cover	-0.005	0.003	0.008				
Desert hackberry cover	-0.307	0.056	0.122				
Greythorn cover	0.925	0.119	0.245				
Wolfberry cover	0.426	0.037	0.544				

[1] *The contribution to r^2 for each variable is the amount by which r^2 would be reduced if that variable were removed from the regression equation.*

(e.g., desert hackberry), which the Arizona pocket mouse strongly avoids (Wondolleck 1978).

Both Bailey's pocket mouse and the Arizona pocket mouse are burrowing rodents that avoided the riparian island. This was probably because of three factors: inadequate burrowing substrate consisting mostly of easily collapsible sand; the lack of a suitable food source (most of the shrub and herbaceous species used by these species were conspicuously absent from the riparian habitats); and a high water table coupled with irregular and pronounced flooding.

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